SPECIFICATION

Electronic Version 1.2.8

Stylesheet Version 1.0

[SIGNAL FREQUENCY SPLITTER AND FREQUENCY SHIFT KEY DECODING APPARATUS USING THE SAME]

Cross Reference to Related Applications

This application claims the priority benefit of Taiwan application serial no. 91119482, filed on August 28, 2002.

Background of Invention

[0001] Field of the Invention

[0002] The invention relates in general to a wireless communication receiving circuit using frequency shift key (FSK), and more particular, to a signal frequency splitter obtaining a plurality of local carrier signals used in frequency shift key by a frequency mixture manner and a frequency shift key decoding apparatus using the signal frequency splitter.

[0003] Related Art of the Invention

[0004] The conventional computer system is composed of a display, a computer host and some electrically connected peripherals. Peripherals operated by the user are restricted by the range of the computer desk. The fast development of the computer industry, plus the broad application of the Internet, has connected computers to the daily lives of many people. In addition, competition and the demand for light, thin, short and small exterior features continuously demands for the enhancement of operation speed and convenience in the industry. The peripheral related industry has developed some wireless input apparatus such as a wireless mouse, wireless

keyboard, and has even converted USB interfaced peripherals into wireless Such apparatus provides operation convenience for the user, by reducing the problems of wire connection.

[0005] If the peripherals are all converted into wireless equipment such as a wireless mouse and wireless keyboard, each piece of the equipment requires an individual wireless transmitter and an individual receiver. The extra cost is significant. Further, interference for signal transmission is inevitable. In addition, too many wireless peripherals may be problematic for integrating home appliances with the computer. Therefore, using the frequency shift key communication technique to integrate all the wireless transceivers into a single entity can offer a good resolution.

[0006] It is known in the art that the frequency shift key communication technique uses radio frequency signals with different frequencies as carriers to emit for different data. The data for different peripherals can thus be transmitted to the receiver via wireless communication simultaneously. In contrast, the receiver has to generate a plurality of corresponding local carrier signals for data signal separation and reduction. Figure 2 shows a conventional multi-function wireless receiver supporting multiple peripherals. Referring to Figure 2, the receiver has an oscillation crystal 134 and vibration initiator (not shown) to provide system frequency signal F_s required for operation of microprocessor 136. The system frequency signal F_s is supplied to a plurality of frequency synthesizers 251, 252, ... , 25n simultaneously. According to the system frequency signal F_s, the frequency synthesizers 251, 252, ... , 25n generate a plurality of local carrier signals F_{b1}, F_{b2}, ... , F_{bn}. When the wireless receiver is operated, the low noise amplifier 124 amplifies the signal received by the antenna 122 to obtain a radio frequency signal. The mixersM_{21}, M_{22} to M_{2n} mix the radio frequency signal with the local carrier signals F_{b1}, F_{b2} to F_{bn}. After being filtered by the intermediate-frequency filter 128, a plurality of intermediate-frequency signals corresponding to the data transmitted from different peripherals are obtained. As shown in Figure 2, the frequencies of the local carrier signals F_{b1}, F_{b2} to F_{bn} in the multi-function wireless receiver that supports multiple peripherals can be randomly changed. However, the n frequency synthesizers and one oscillation crystal required for generating local carrier signals F_{b1}, F_{b2} to F_{bn} are very costly.

[0007] Figure 3 shows another multi-function wireless receiver that supports multiple peripherals. In Figure 3, in addition to the oscillation crystal 134 and the vibration initiator (not shown) required to generate the system frequency signal F_s required for the operation of the microprocessor 136, the receiver further uses a plurality of different oscillators 351, 352, ... , 35n and vibration initiators (not shown) to generate local carrier signals F_{b1}, F_{b2} to F_{bn} used for data signal separation and frequency reduction. In the conventional receiver, (n+1) oscillation crystals and vibration initiators are used. The more peripherals to be supported, the more oscillation crystals and vibration initiators are required. Consequently, the cost is increased. Being restricted by the fixed radio frequency baseband signal, the frequency cannot be changed.

[0008] According to the above, the multi-function wireless receiver supporting multiple peripherals has the following drawbacks.

[0009] 1. If the signal frequency splitter uses a plurality of frequency synthesizers to generate a plurality of local carrier signals, though the frequency of the local carrier signals can be randomly changed, the system is very costly.

[0010] 2. If the signal frequency splitter uses a plurality of oscillation crystals and vibration initiators to generate a plurality of local carrier signals, the cost is high, the frequency of the local carrier signals cannot be changed, and the system flexibility is poor.

[0011] 3. In the above two approaches, the restriction in cost and circuit design causes the frequency shift key decoding apparatus formed by integrating a signal frequency separation apparatus and the demodulator into a single chip to be difficult.

Summary of Invention

[0012] The present invention provides a signal frequency splitter and a frequency shift key decoding apparatus using the same. The frequency of the local carrier signal can be randomly changed. The fabrication cost is low. The signal frequency splitter and the frequency shift key decoding apparatus can be implemented into a signal chip using a digital circuit.

[0013] The frequency shift key decoding apparatus comprises a frequency divider, a signal frequency splitter and a demodulator. The frequency divider divides a system frequency signal F_s into n-1 differential frequency signals F_{d2} to F_{dn}. The signal frequency splitter coupled to the frequency divider generates n local carrier signals F_{b1} to F_{bn} according to the system frequency signal F_s and the n-1 differential frequency signals F_{d2} to F_{dn}. The signal frequency splitter receives a radio frequency signal and performs filtering after the radio frequency signal is mixed with the n local carrier signals F_{b1} to F_{bn} to obtain n intermediate-frequency signals. Via the demodulator coupled to the signal frequency splitter, the n radio intermediate-frequency signals are decoded to obtain n data, where "n" is an integer equal to or larger than 2.

[0014] The present invention further provides a signal frequency splitter to obtain n intermediate-frequency signals from a radio frequency signal. The signal frequency splitter comprises a frequency synthesizer, n-1 first mixers, n second mixers and n filters. "n" is an integer equal to or larger than 2. The frequency synthesizer synthesizes the local carrier signal F_{b1} according to the system frequency signal F_s. The first mixers are denoted by M_{12} to M_{1n}. The n-1 first mixers are all coupled to the frequency synthesizer to mix the radio frequency signal F_{b1} with n-1 differential frequencies F_{d2} to F_{dn} to obtain n-1 local carrier signals F_{b2} to F_{bn} different from the local carrier signal F_{b1}. The second mixers denoted as M_{21}, M_{22} to M_{2n} are coupled to the frequency synthesizer and the corresponding n-1 first mixers to mix the radio frequency signal and the above local carrier signals F_{b1} to F_{bn}, so as to obtain n intermediate-frequency mixed frequencies F_{m1} to F_{mn}. The n filters are coupled to the respective n second mixers to filter the intermediate-frequency mixed frequencies F_{m1} to F_{mn} to obtain different n intermediate-frequency signals.

[0015] In one embodiment of the present invention, the frequency shift key decoding apparatus further includes a low-noise amplifier to amplify the signal received from an antenna to obtain the radio frequency signal. In addition, the radio frequency signals F_{b1} to F_{bn} include signals with frequencies of 26.995 MHz, 27.045MHz and 27.095 MHz, 27.145 MHz, 27.195 MHz, and/or 27.255 MHz while the carrier frequency of the intermediate-frequency signal is 455KHz.

[0016] In summary, the present invention comprises a signal frequency splitter to obtain a first intermediate-frequency signal and a second intermediate-frequency signal from a radio frequency signal, which further comprises a first mixer, a plurality of second mixers and a plurality of filters. The first mixer is used to mix frequencies of the first local carrier signal and the differential frequency signal to obtain the second local carrier signal. The second mixers coupled to the first mixer are used to mix the frequency of the first radio frequency with the frequency of the first local carrier signal and the frequency of the second local carrier signal to obtain the first and second intermediate-frequency frequency-mixed signals, respectively. The filters coupled to the second mixers then filter the first and second intermediate-frequency frequency-mixed signals to obtain the first and the second intermediate-frequency signals. The function of these filters is to filter the noise or interference other than the first and the second intermediate-frequency signals, so as to improve the signal to noise ratio.

[0017] In the present invention, only n-1 mixers M_{21} to M_{2n} are used to generate a plurality of local carrier signals F_{b1} to F_{bn} for separation and frequency reduction of the data signal. The mixers occupy very small area of the integrated circuit chip, such that the cost is low. Further, the mixers can be easily implemented by a digital circuit, so that the whole system, particularly the frequency shift key decoding apparatus, can be formed in a single chip.

Brief Description of Drawings

[0018] These, as well as other features of the present invention, will become more apparent upon reference to the drawings wherein:

[0019] Figure 1 shows a multi-function wireless receiver able to support multiple peripherals simultaneously according to one embodiment of the present invention;

[0020] Figure 2 shows a conventional multi-function wireless receiver to support multiple peripherals, wherein a plurality of frequency synthesizers are used to generate a plurality of local carrier signals; and

[0021] Figure 3 shows another conventional multi-function wireless receiver to support multiple peripherals, wherein a plurality of different oscillation crystals and vibration initiators are used to generate a plurality of local carrier signals.

Detailed Description

[0022] Figure 1 shows a multi-function wireless receiver able to support multiple peripherals simultaneously according to one embodiment of the present invention. The related industry of the peripherals provides wireless input apparatus such as a wireless mouse, wireless keyboard, and peripheral devices originally using USB interfaces to enhance operation efficiency and convenience. These wireless peripherals use radio frequency signals with different frequencies as the carriers to transmit data with different functions in radio frequency signals to the multi-function wireless receiver 120 able to support multiple peripherals simultaneously.

[0023] The multi-function wireless receiver 120 includes an antenna 122, a microprocessor 136, an interface 138, an oscillation crystal 134, a vibration initiator (not shown), and a frequency shift key decoding apparatus 110 provided by the present invention. The frequency shift key decoding apparatus 110 includes a frequency divider 140, a low-noise amplifier 124, a signal frequency splitter 100 and a demodulator 132. The signal frequency splitter 100 provided by the present invention further comprises a frequency synthesizer 150, n-1 first mixers M_{12} to M_{1n}, n second mixers M_{21}, M_{22} to M_{2n} and n filters 128, where "n" is a positive integer larger the 2.

[0024] In one embodiment of the present invention, the wireless receiver 120 includes only one oscillation crystal 134 and one vibration initiator (not shown) to provide the system frequency signal F_s required by operation of the microprocessor 136. When the wireless receiver is operated, the antenna 122 receives a small radio frequency signal transmitted from various peripherals. After the small radio frequency signal the frequency shift key decoding apparatus 110, the signal separation and frequency reduction according to frequency shift key communication technique is performed to obtain a plurality of signals corresponding various peripherals. The signals are then decoded, such that the frequency shift key decoding apparatus 110 can output a plurality of data transmitted from various peripherals to the microprocessor 136. According to the protocol between the microprocessor 136 and the computer system, data for various peripherals are transmitted to the computer system through proper ports such as PS2 connector, mouse connector, PS2 keyboard connector and USB connector via the interface 138.

[0025] The system frequency signal F_s can be provided to both the frequency divider 140 and the frequency synthesizer 150 at the same time. Therefore, the frequency synthesizer 150 can generate the basic local carrier signal F_{b1} in the wireless receiver 120 according to the system frequency signal F_s. The frequency divider 140 can also divides the frequency of the system frequency signal F_s to obtain n-1 differential frequency signals F_{d2} to F_{dn}. The actual frequencies of the differential frequency signals F_{d2} to F_{dn} are obtained by subtraction between the frequency of respective local carrier signals for respective peripheral apparatus and the frequency of the local carrier signal F_{b1}. For example, n-1 differential frequency signals can also be obtained by a plurality of differential frequency signals generated every 50KHz. The low-noise amplifier 124 amplifies the small radio frequency signal received by the antenna 122 to obtain the radio frequency signal. According to the system frequency signal F_s and the n-1 differential frequency signals F_{d2} to F_{dn}, n local carrier signals F_{b1} to F_{bn} are generated by the signal frequency splitter 100. Being received by the signal frequency reduction apparatus 100 and mixed with the n local carrier signals F_{b1} to F_{bn}, the radio frequency signals are further filtered to obtain n intermediate-frequency signals. The n intermediate-frequency signals are decoded by the demodulator 132 to obtain n data corresponding to various peripherals.

[0026] It is known to people of ordinary skill in the art that the above low-noise amplifier 124 does not have to be included in the frequency shift key decoding apparatus 110. Instead, the low-noise amplifier 124 can be independently disposed in the wireless receiver 120. Or alternatively, the low-noise amplifier 124 can be removed from the wireless receiver 120, depending on the signal intensity and the receiving environment.

[0027] The signal frequency-reduction splitter 100 separates the radio frequency signals of various peripherals into the n intermediate-frequency signals corresponding to the peripherals. The local carrier signal F_{b1} is synthesized by the frequency synthesizer 150 according to the system frequency signal F_s. As known to people of ordinary skill in the art, the frequency synthesizer 150 is not necessarily included in the signal frequency splitter 100, but can be disposed in the frequency shift key decoding apparatus 110 independently.

[0028] The n-1 first mixers M_{12} to M_{1n} are all coupled to the frequency synthesizer to mix frequencies of the local carrier signal F_{b1} with the n-1 differential frequency signals F_{d2} to F_{dn}. According to the frequency mixture theory of communication theory, the frequency-mixed signal includes a signal with the frequency difference between two signals before mixture. As the differential frequency signals F_{2d} to F_{2n} are obtained from subtraction between different frequencies of different radio frequency signals for different peripherals and the local carrier signal F_{b1}, the frequency-mixed signal includes n-1 local carrier signals F_{b2} to F_{bn} of the carrier frequencies used by different peripherals. The local carrier signals F_{b2} to F_{bn} are different from the local carrier signal F_{b1}.

[0029] The n second mixers M_{21}, M_{22} to M_{2n} are coupled to the corresponding frequency synthesizer and the n-1 first mixers, so that the n second mixers M_{21}, M_{22} to M_{2n} mix frequencies of the radio frequency signal and the above local carrier signals F_{b1} to F_{bn}. Similarly, the n intermediate-frequency frequency-mixed signals F_{m1} to F_{mn} including data of various peripherals are obtained. The n filters 128 are coupled to respective corresponding second mixers M_{21}, M_{22} to M_{2n}, such that the intermediate-frequency frequency-mixed signal F_{m1} to F_{mn} are filtered to remove the signals with frequency other than the mixed frequency. Consequently, n intermediate-frequency signals are obtained.

[0030] In one embodiment of the present invention, the local carrier signals F_{b1} to F_{bn} include signals with frequencies of 26.995 MHz, 27.045MHz and 27.095 MHz, 27.145 MHz, 27.195 MHz, and/or 27.255 MHz, and the carrier frequency of the intermediate-frequency signal is 455KHz.

[0031]

It is known in the art that when there are only two radio frequency signals, the signal frequency splitter obtains only a first intermediate-frequency signal and a second intermediate-frequency signal from the radio frequency signals. Only one first mixer is required to mix the first radio frequency signal with the differential frequency signal to derive the second local carrier signal. The (two) second mixers coupled to the first mixer mixes the frequency of the radio frequency signal and the frequency of the first and the second local carrier signals to obtain a first and second intermediate-frequency frequency-mixed signal. Through the (two) filters coupled to the second

mixers, the first and second intermediate-frequency frequency-mixed signals are filtered to obtain the first and the second intermediate-frequency signals. The function of these filters is to filter the noise or interference other than the first and the second intermediate-frequency signals, so as to improve the signal to noise ratio.

[0032] In the present invention, as the n-1 differential frequency signals F_{d2} to F_{dn} are obtained by dividing frequency of the system frequency signal F_s via the frequency divider 140, and only n-1 mixers M_{21} to M_{2n} are used to generate a plurality of local carrier signals F_{b1} to F_{bn}, the frequency of the local carrier signal can thus be changed randomly. Further, as the frequency divider 140 and the mixers occupy very small area of the integrated circuit chip compared to the conventional frequency synthesizers or the oscillation crystals and vibration initiator, the cost of the present invention is low, and the implementation is easily achieved using a digital circuit. Therefore, the frequency shift key decoding apparatus 110, or even the whole wireless receiver 120 is easily implemented on a single chip.

[0033] Other embodiments of the invention will appear to those skilled in the art from consideration of the specification and practice of the invention disclosed herein. It is intended that the specification and examples be considered as exemplary only, with a true scope and spirit of the invention being indicated by the following claims.